Targeted Sewer Inspection Pilot Report

Contents

1 -Executive Summary:

DEP created the Targeted Sewer Inspection Pilot (TSIP) to pilot and assess a program to inspect and perform maintenance on sanitary sewers in geographical areas with higher rates of sewer backup (SBU) complaints. The program aims to identify sewer segments that may benefit from frequent inspection and/or maintenance with a goal of reducing the frequency of SBU complaints.

Each sanitary sewer in the selected geographical areas was inspected twice over a period of three years. DEP performed corrective maintenance work as required based on the observed sewer conditions. At the end of the three-year period, DEP analyzed the inspection data and SBU complaint data both to determine the lessons learned from the program and to provide a blueprint for further targeted actions.

Data collected during the TSIP pilot period from 2017-2020 (TSIP Phase 1 or Phase 1) revealed that the TSIP areas saw a reduction of 30% in confirmed sewer backup complaints per 100 sewer miles.[1] Accordingly, DEP has committed additional resources to expand the TSIP to new geographical areas for assessment and analysis as part of Phase 2 of the TSIP (TSIP Phase 2 or Phase 2). DEP intends to inspect and perform maintenance in these additional areas for another three-year period in order to compare data with the areas addressed under Phase 1. In addition, DEP will target additional inspection and maintenance actions on a street-by-street basis in the TSIP Phase 1 areas where Phase 1 inspection results indicate recurring sewer issues. Further, DEP intends to investigate and implement corrective maintenance, as needed, in areas where SBU complaint rates did not show marked improvement during Phase 1 of the TSIP.

2 Definitions
As used in this Report, these terms are defined as follows:

BWSO (Bureau of Water and Sewer Operations): DEP's bureau responsible for the maintenance of NYC's 7,000 miles each of sewers and water mains.

CCTV (Closed Circuit TV): Work in which the inside of a sewer is televised to assess structural condition.

Confirmed SBU: DEP deems an SBU confirmed when a backup complaint, upon field investigation, is determined to be associated with a condition in DEP's sewer system. Such conditions include surcharging, temporary overtaxing, blockages, and collapses.

Crown Sewer Street Segment: Street segment in which sewer flow begins in a single manhole with no City sewer inlets and continues in at least two directions from the manhole. See example diagram below. "O" indicates a crown manhole; "o" indicates a non-crown manhole; "<--" and "-->" indicate the flow of the sewer:

> Crown Sewer Street Segment Diagram: o<--o<--**O**-->o-->o

CSI (Collection Systems Investigation): BWSO's section that investigates and develops site-specific plans and recommendations to alleviate sewer issues.

Dead End Sewer Street Segment: Street segment in which sewer flow begins in a single manhole with no City sewer inlets and continues in only one direction from the manhole. See example diagram below. "O" indicates a dead end manhole, "o" indicates a non-dead end manhole, "<--"and "-->" indicate the flow of the sewer

> Dead End Sewer Street Segment Diagram: o<--o<--o<--**O**

Dry Day: A day in which the average daily precipitation recorded at NYC's three major weather stations (Central Park, LaGuardia Airport, and JFK Airport) is less than or equal to 0.1 inches.

IPS (Infor Public Sector): DEP's computer system that serves as a repository for customer complaints, inspections, and work orders for BWSO. Formerly known as the Hansen system.

Liquid Degreasing (LDG): DEP's program that tracks grease-related sewer problems and generates scheduled corrective maintenance (adding liquid degreaser). If a location has an occurrence of two grease-related issues within a 6-month period, the location is added to a programmatic degreasing schedule (monthly, quarterly, biannually, or yearly) depending on grease severity.

Recurring Sewer Backup: Confirmed SBU complaint that originates on the same street segment at least twice in a rolling 3-month period, as defined by the current SOAP program.

SBU Operations and Analysis Program (SOAP): A geospatial analysis of 311 data produced monthly that indicates areas in the city experiencing recurring Confirmed SBU complaints and the actions associated with addressing those instances.

SBU Recurring After SOAP (SRAS): Once DEP completes remedial measures through SOAP, the sewer segment enters a one-year monitoring period. During that time, if an additional Confirmed SBU occurs on that segment, DEP identifies the segment as an SRAS segment and assigns it to DEP's Collection Systems Investigation (CSI) section to develop and implement an action plan tailored to site-specific conditions.

Sewer Backup (SBU) complaint: A customer service request (CSR) by a property owner or other individual alleging that a problem with a City sewer is impacting the property and causing an SBU.

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[1] In the 5 areas with the next highest rates of sewer backup complaints where TSIP had not been implemented, there was a reduction of 22% - see page 9 of this report.

Sewer segment: the length of sewer from one manhole to the adjacent manhole. In cases where multiple barrels are present, the sewer segment generally includes all barrels.

Sewer surcharge (surcharge): Condition where the flow observed in a sewer manhole is above the crown (top) of the sewer pipe.

Sewershed: A network of sewer pipes draining to one of NYC's fourteen (14) Wastewater Resource Recovery Facilities.

Street segment: the portion of the street from one intersection to the next; may also be referred to as one street block.

Sub-sewershed: a sub-network of sewers draining to a single outlet location within one of NYC's sewersheds as defined above.

Trunk Sewer: Any gravity sewer equal to or greater than 18 inches in diameter

TSIP Inspection Rating: A rating of either 1 or 0 given to a TSIP manhole inspection. A rating of 1 indicates a found maintenance issue while 0 indicates no maintenance issues found during the inspection.

TSIP Segment Rating: A rating of 0, 1, or 2 given to a street segment that contains manholes included in TSIP. A rating of 0 indicates no maintenance issues were found in any manhole on the street segment during both rounds of inspections. A rating of 1 indicates maintenance issues were found in at least one manhole during only one of the two rounds of inspections. A rating of 2 indicates maintenance issues were found in at least one manhole on the street segment during both inspection rounds.

Unconfirmed SBU: DEP deems an SBU as unconfirmed when a backup complaint, upon field investigation, exhibits none of the characteristics of a Confirmed SBU. In such situations, the condition can be associated with an internal condition or a problem with the private sewer connection, or may be otherwise unfounded.

Wet Day: A day in which the average daily precipitation recorded at NYC's three major weather stations (Central Park, LaGuardia Airport, and JFK Airport) is greater than 0.1 inches.

3 - Targeted Sewer Inspection Pilot (TSIP) Background

TSIP is a proactive, data-driven sewer inspection program in targeted areas, supplementing DEP's SBU response system, including the existing SOAP, SRAS, and LDG maintenance programs. Through Phase 1 of the TSIP, DEP worked to (i) identify sewer segments that may benefit from frequent inspection and (ii) establish an appropriate cycle to conduct such inspections on an ongoing basis. By conducting proactive inspections of sanitary sewers in these sewer segments, DEP sought to identify and undertake maintenance activities before a Confirmed SBU occurred with the goal of reducing the frequency of Confirmed SBUs. Based on the results of the TSIP Phase 1, DEP has committed resources to the implementation of TSIP Phase 2. Thus, the three TSIP phases are:

1.   Pilot Development Phase (completed): DEP conducted inspections in areas selected for TSIP to determine the efficacy of various inspection methods and to make preliminary resource projections for later phases of TSIP.

2.   Pilot Phase 1 (formerly Pilot Phase, completed): DEP completed two cycles of regular inspections of all sanitary sewers over a three-year period (2017-2020) in selected geographic areas with high SBU rates to collect data on sewer condition and establish an appropriate frequency of ongoing inspections for specific sewer segments.

3.   Pilot Phase 2 (in progress): DEP will complete two cycles of regular inspections of all sanitary sewers in additional geographic areas with high SBU rates over the period August 2020 - July 2023. DEP has analyzed the data collected during Phase 1 of the pilot and has used that analysis to inform further targeted inspections in the original Phase 1 geographic areas.

3.1 - Pilot Development Phase (October 2016 through March 2017)

DEP conducted a pilot development phase from October 2016 through March 2017. During the pilot development phase, DEP compared two different methods of sewer inspection (visual inspection and pole camera inspection) to identify the most efficient method for conducting programmatic sewer inspections and to estimate the level of resources required for later inspection phases. DEP determined that more frequent, visual inspections would likely achieve greater reductions in SBUs than the more sensitive, but more time-intensive pole camera inspections.

3.2 - Pilot Phase 1 (July 1, 2017 through July 31, 2020)

Using the information gathered in the pilot development phase, DEP launched Phase 1 of the pilot in July 2017, and performed two cycles of regular visual inspections of the sanitary sewers across geographic areas with the highest number of SBUs. The geographic areas selected were Community Boards 412 and 413 in Queens, and Community Boards 313 and 315 in Brooklyn. To ensure that inspection crews could conduct a more detailed inspection if needed, crews had a pole camera available during visual inspections.

3.2.1 Inspections

DEP conducted 51,756 inspections during Phase 1 of the pilot program to reach its goal of inspecting every sanitary sewer in these Community Boards twice during the three-year period. The pace of annual inspections is detailed below:

1.   Fiscal Year 2018 (July 2017 – June 2018): 13,611 sewer segment inspections

2.   Fiscal Year 2019 (July 2018 – June 2019): 24,417 sewer segment inspections

3.   Fiscal Year 2020 (July 2019 – June 2020): 13,726 sewer segment inspections

Because of impacts from COVID, DEP performed the last inspections in July 2020 (FY2021).[2]

DEP performed inspections using a mobile web application tied to DEP's IPS work order system, so that any defects observed during inspections generated corrective work orders that were consolidated in a daily sync of the system. Additionally, crews performed inspections with flusher trucks to flush the sewer immediately if crews found the sewer surcharged during an inspection.

3.3 Work Performed

The 51,756 inspections generated 7,143 flow-impacting work orders. This work included 6,130 flushing and vactoring work orders, 649 degreasings, 335 manhole cleanings, and 29 CCTV work orders for further sewer investigation. DEP completed work on average within 90 days of the associated inspection.

4 – Analysis Methodology

4.1 Analysis Questions

This analysis aims to answer the following questions:

1. Did the TSIP program reduce SBUs in the pilot Community Boards when compared to other Community Boards with high SBU rates and no TSIP?
2. What do the TSIP results reveal about SBU prevention?
3. Are "variable" relationships (such as sewer characteristics or tax lot variables) instructive metrics in determining inspection/cleaning frequencies/schedules?
4. How many more segments would fall under SOAP if DEP evaluated recurring SBUs on 12-month rolling period basis rather than a 3-month rolling period?

4.2 Data Sources

Various data sources were used to create aggregated datasets, which DEP used to explore potential relationships among inspection results, confirmed SBU complaints, sewer characteristics, capital projects, and tax lot characteristics over a range of geographical areas.

4.2.1 IPS

DEP's IPS system was the source of several datasets used in this analysis. The TSIP mobile web application syncs daily with IPS to both store inspection information and generate work orders. For this analysis, DEP used the following data:

1. TSIP inspections from Phase 1 of the Pilot (FY2017-FY2020)
2. Proactive and Reactive Sewer Work Orders from FY2010 - FY2020
3. Confirmed and Unconfirmed SBU complaints from 311 from FY2010 – FY2020, excluding the 109 December 2019 South Ozone Park incident SBUs, and 15 SBUs due to contractor pumping issues on Lakeview Blvd from February – March 2019.

4.2.2 Sewer GIS Layers

BWSO maintains comprehensive GIS layers of NYC's sewer network, including sewer pipes and manholes, with information regarding age, material, length, and invert elevations. DEP used this dataset to analyze characteristics of NYC's sewer infrastructure against SBU complaints and the results of Phase 1 TSIP inspections.

4.2.3 NYC Open Data

NYC LION (New York City Linear Integrated Ordered Network) is a street centerline GIS layer of NYC maintained by the Department of City Planning. Most LION segments correspond to a single physical city street block and, in this Report, are referred to as "street segments." DEP used this layer to relate SBU complaint data from IPS with sewer characteristics from BWSO's GIS layers as well as TSIP inspections on a city block level.

MapPLUTO (Primary Land Use Tax Lot Output Map) is a GIS tax lot layer also maintained by the Department of City Planning. DEP used this layer to analyze a variety of factors including housing density and building usage against TSIP inspections and SBUs.

4.2.4 Capital Projects

DEP used a layer of sewer capital projects maintained by DDC and EDC to investigate any relationship between SBUs and capital sewer upgrades in the Phase 1 TSIP areas.

4.2.5 Precipitation

DEP used precipitation data from NYC's three major weather stations (Central Park, JFK Airport, and LaGuardia Airport), sourced from NOAA's National Centers for Environmental Information to analyze the impact of precipitation on SBUs in the Phase 1 TSIP areas.

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[2] DEP notified EPA on 6/24/2020 of a possible COVID-related delay in completing the pilot inspections by 6/30/20, and on 6/24/2020 EPA approved a one-month extension until 7/31/2020.

4.3 Aggregated Datasets

DEP aggregated several datasets from the above sources by geographic area, with the following datasets moving from larger to smaller unit areas.

1. Community Boards
   DEP aggregated SBU statistics on the Community Board level to be able to compare TSIP Phase 1 Community Boards with non-TSIP Community Boards.
2. TSIP Inspection Zones
   DEP divided inspection areas into smaller areas of sub-sewersheds, each of which DEP could inspect within 3-4 weeks: Brooklyn into 11 zones, labeled BK-Z1 to BK-Z11, and Queens into 25 zones, labeled QN-Z1 to QN-Z25. DEP used these zones as mid-level aggregation areas to compare variables useful at this detail level.
3. LION Street Segments
   DEP used these segments to aggregate various data at the city street level for a finer-grained analysis.

4.4 – Phase 1 TSIP Inspection Data Processing

To rate the sewer condition data from the Phase 1 TSIP inspections, each manhole was assigned a value of 0 if there were no issues found, or a value of 1 if the inspection data showed ANY of the following issues with the sewer:

a) The sewer was found surcharged OR
b) The sewer showed signs of recent surcharge OR
c) The inspection noted a defect in the sewer not associated with overtaxing (e.g., grease, debris, defect) OR
d) The inspection generated a flow-related work order (flush, vactor, clean manhole, degrease, or refer for an engineering investigation).

The inspections were aggregated by street segment with each street segment receiving a rating of 0, 1 or 2 based on the following criteria:

0- No manhole inspection on the street segment in either the first or second inspection cycle indicated any issues with the sewer, as defined above.
1- At least one manhole inspection on the street segment during either the first OR second inspection cycle (but NOT both) indicated an issue with the sewer.
2- At least one manhole on the street segment during BOTH the first and second inspection cycle indicated an issue with the sewer.

DEP chose these rating criteria to characterize the frequency of sewer issues found on a particular street segment. Below is a graphic showing an example of this rating system.

Street Segment Rating Example

5 – Analysis Results

5.1.1 Inspection Results

Borough	Community Board	Street Segments associated with TSIP inspections	Segments with No Sewer Issues	Segments with 1 cycle sewer issue	Segments with 2 cycle sewer issue	% of TSIP segments with no issues	% of TSIP segments with 1 cycle issues	% of TSIP Segments with 2 Cycle Issues
Brooklyn	**Total**	**2,495**	**1,493**	**886**	**116**	**60%**	**36%**	**5%**
	313	823	424	336	63	52%	41%	8%
	315	1,672	1,069	550	53	64%	33%	3%
Queens	**Total**	**6,995**	**4,206**	**2,025**	**764**	**60%**	**29%**	**11%**
	412	3,561	2,231	1,007	323	63%	28%	9%
	413	3,434	1,975	1,018	441	58%	30%	13%
Grand Total		**9,490**	**5,699**	**2,911**	**880**	**60%**	**31%**	**9%**

Out of 9,490 street segments with associated Phase 1 TSIP inspections in Brooklyn and Queens, 60% recorded no sewer issues during both cycles of Phase 1 TSIP inspections on those segments, 31% of segments recorded issues during only one cycle, and 9% recorded issues during both Phase 1 TSIP cycles (Queens 11% with issues during both cycles, Brooklyn 5%).

When DEP found the sewer surcharged during a Phase 1 TSIP inspection, inspection crews immediately flushed the sewer to bring the level down. DEP has characterized these occurrences as potential SBUs averted. Phase 1 of TSIP recorded 418 such occurrences over the three years of the pilot. Below is a table showing the number of potential SBUs averted by borough and Community Board during Phase 1.

Borough	Community Board	Potential SBUs Averted
Brooklyn	313	70
	315	77
	Total	**147**
Queens	412	152
	413	119
	Total	**271**
Total		**418**

5.1.2 SBUs Occurring After TSIP Phase 1 inspections

This section aims to identify locations where SBUs occurred after TSIP inspections and associated work. This analysis focuses on confirmed SBUs that occurred within 120 days of inspection during the three years of the Phase 1 period. The 109 confirmed SBUs in CB 412 stemming from the Ozone Park incident and the 15 confirmed SBUS from the Lakeview Blvd pumping issues were not included.

TSIP Phase 1 Confirmed SBUs within 120 Days After Inspection

Borough	TSIP Segment Count	SBU Count within 120 days	Segments with SBUs within 120 days	Segments with Multiple SBUs within 120 days
⊟ **Brooklyn**	2495	54	39	8
313	823	20	16	2
315	1672	34	23	6
⊟ **Queens**	6995	224	156	37
412	3561	148	106	25
413	3434	76	50	12
Total	**9490**	**278**	**195**	**45**

Out of 9,490 street segments with associated TSIP inspections, 195 street segments (2%) had confirmed SBUs within 120 days of inspection, totaling 278 SBUs.[3] 45 (0.5%) of these segments had multiple confirmed SBUs within this time.

Of those 195 street segments:
- 120 (1.2%) segments had SBUs after an inspection that had not generated any cleaning
- 18 (0.1%) segments had SBUs before cleaning was completed but not after cleaning
- 6 (0.06%) had SBUs both before and after cleaning, and
- 54 (0.5%) segments had SBUs after cleaning work was completed, but not between inspection and cleaning.
- 3 of the segments belonged to more than one group.

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[3] 235 of the 278 SBUs (84%) were grease-related

Breakdown Of Street Segments With Confirmed SBUs Within 120 Days

Borough	Segments with No Cleaning Needed	Segments with SBUs Before Cleaning	Segments with SBUs Before and After Cleaning	Segments with SBUs After Cleaning	Total
⊟ **Brooklyn**	**27**	**7**	**2**	**4**	**40**
313	10	2	1	3	16
315	17	5	1	1	24
⊟ **Queens**	**93**	**11**	**4**	**50**	**158**
412	63	4	3	38	108
413	30	7	1	12	50
Total	**120**	**18**	**6**	**54**	**198**

DEP is recommending further investigation of these 195 segments.

TSIP Phase 1 Inspection Results By Street Segment - Brooklyn

Legend

- TSIP Phase 1 Area
- Community Districts

TSIP Street Segment Rating

- 0 (No flow issues during either inspection cycle)
- 1 (Flow issue during one of two inspection cycles)
- 2 (Flow issue during both inspection cycles)

Legend

TSIP Phase 1 Area
Community Districts

TSIP Street Segment Rating
0 (No flow issues during either inspection cycle)
1 (Flow issue during one of two inspection cycles)
2 (Flow issue during both inspection cycles)

5.2 - Sewer Backup Rates

5.2.1 TSIP Phase 1 Community Boards vs Citywide Community Boards

One comparison to be made is the rate of confirmed SBU complaints from before the TSIP Phase 1 program to the rate during Phase 1. In the TSIP Phase 1 Community Boards (313, 315, 412, and 413), the average confirmed SBU rate declined 30% from FY15-FY17 to FY18-FY20, while the citywide rate declined 19% during the same period. The average confirmed SBU rates of the five non-TSIP Community Boards (CBs 414, 410, 314, 318 and 502) with the highest SBU rates declined 22% on average between the two periods (Community Board 501 was not included in the five because it was unofficially included in the TSIP pilot). The 109 confirmed SBUs in CB 412 stemming from the Ozone Park incident and the 15 confirmed SBUS from the Lakeview Blvd pumping issues were not included.

Therefore, we may conclude, based on the data collected during Phase 1, that in high-SBU areas, TSIP Phase 1 Community Boards outperformed non-TSIP Community Boards by 8% in reduction of confirmed SBUS.

Confirmed SBUs per 100 Miles of Combined & Sanitary Sewer by Community District

										Pilot Period								
Updated: 03/01/21			FY2015		FY2016		FY2017		FY2018		FY2019		FY2020		Data through 03/01/21			
CB District	Combined & Sanitary Sewer Miles	% of Total Sewer System**	Confirmed SBU Count	Rate per 100 Miles of Sewer	Confirmed SBU Count	Rate per 100 Miles of Sewer	Confirmed SBU Count	Rate per 100 Miles of Sewer	Confirmed SBU Count	Rate per 100 Miles of Sewer	Confirmed SBU Count	Rate per 100 Miles of Sewer	Confirmed SBU Count	Rate per 100 Miles of Sewer	CB District	Average Rate FY15-FY17	Average Rate FY18-FY20 (Pilot Years)	% Change in Average Rate
313	59.1	1.1%	85	143.8	73	123.5	88	148.8	60	101.5	63	106.6	78	131.9	313	139	113	-18%
315	137.3	2.5%	123	89.6	134	97.6	98	71.4	98	71.4	46	33.5	53	38.6	315	86	48	-45%
412	235.9	4.3%	467	198.0	460	195.0	364	154.3	371	157.3	269	114.0	288	122.1	412	182	131	-28%
413	259.1	4.8%	252	97.2	210	81.0	218	84.1	208	80.3	133	51.3	130	50.2	413	87	61	-31%
Citywide	5438.8	100.0%	2845	52.3	2507	46.1	2648	48.7	2384	43.8	2171	39.9	1945	35.8	Citywide	49	40	-19%
TSIP Phase 1 Avg. Rate (4 CBs)				134.1		126.8		111.1		106.6		73.9		79.4	TSIP P1 Avg Rate	124	87	-30%
Citywide	(Minus TSIP Phase 1 Boards)			40.4		34.3		39.6		34.7		35.0		29.4	Rate	38	33	-13%
Rate	414,410,314,318,502***			76.7		69.9		86.8		64.7		65.6		51.8		78	61	-22%
Rain	(inches)			44.91		36.15		48.07		41.98		64.07		40.61	Rain			

Rates are highlighted in **red** if they are above the citywide average, and **green** if they are above the TSIP Phase 1 average

***Community Boards with the highest average SBU rates for FY15-FY20 excluding the TSIP Boards and 501

5.2.2 TSIP Phase 1 Inspection Zones SBU Rates

DEP analyzed the data from the TSIP Phase 1 Community Boards to determine the rate of SBUs that occurred before the program vs the rate during the program in each inspection zone. Included were confirmed SBUs that occurred on street segments with at least one sanitary sewer segment.[4]

In Brooklyn, all inspection zones showed a decrease in SBUs from FY15-FY17 to FY18-FY20, with an average decrease of 42%:

Zone	Sanitary Sewer Miles	Combined Sewer Miles	Sanitary SBUs FY15-FY17	Sanitary SBUs FY18-FY20	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY15-FY17	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY18-FY20	Percent Change in SBU Rate
BK-Z1	17.54	0.03	32	27	60.80	51.30	-16%
BK-Z2	16.62	0.71	60	26	120.33	52.14	-57%
BK-Z3	16.38	0.00	21	6	42.74	12.21	-71%
BK-Z4	11.54	0.03	19	15	54.89	43.33	-21%
BK-Z5	17.83		33	10	61.68	18.69	-70%
BK-Z6	12.30	0.01	36	17	97.56	46.07	-53%
BK-Z7	10.34	0.01	43	15	138.57	48.34	-65%
BK-Z8	25.27	5.92	93	75	122.66	98.92	-19%
BK-Z9	22.24	0.41	76	40	113.89	59.94	-47%
BK-Z10	19.39	0.45	65	34	111.73	58.44	-48%
BK-Z11	22.96	0.20	124	121	180.04	175.69	-2%

Below are the top five Brooklyn sub-sewersheds ordered by the highest rates of sanitary SBUs during the TSIP Phase 1 program:

Zone	Sanitary Sewer Miles	Combined Sewer Miles	Sanitary SBUs FY15-FY17	Sanitary SBUs FY18-FY20	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY15-FY17	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY18-FY20	Percent Change in SBU Rate
BK-Z11	22.96	0.20	124	121	180.04	175.69	-2%
BK-Z8	25.27	5.92	93	75	122.66	98.92	-19%
BK-Z9	22.24	0.41	76	40	113.89	59.94	-47%
BK-Z10	19.39	0.45	65	34	111.73	58.44	-48%
BK-Z2	16.62	0.71	60	26	120.33	52.14	-57%

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[4] All data in this section exclude the 109 December 2019 South Ozone Park incident SBUs, and 15 SBUs due to contractor pumping issues on Lakeview Blvd from February – March 2019.
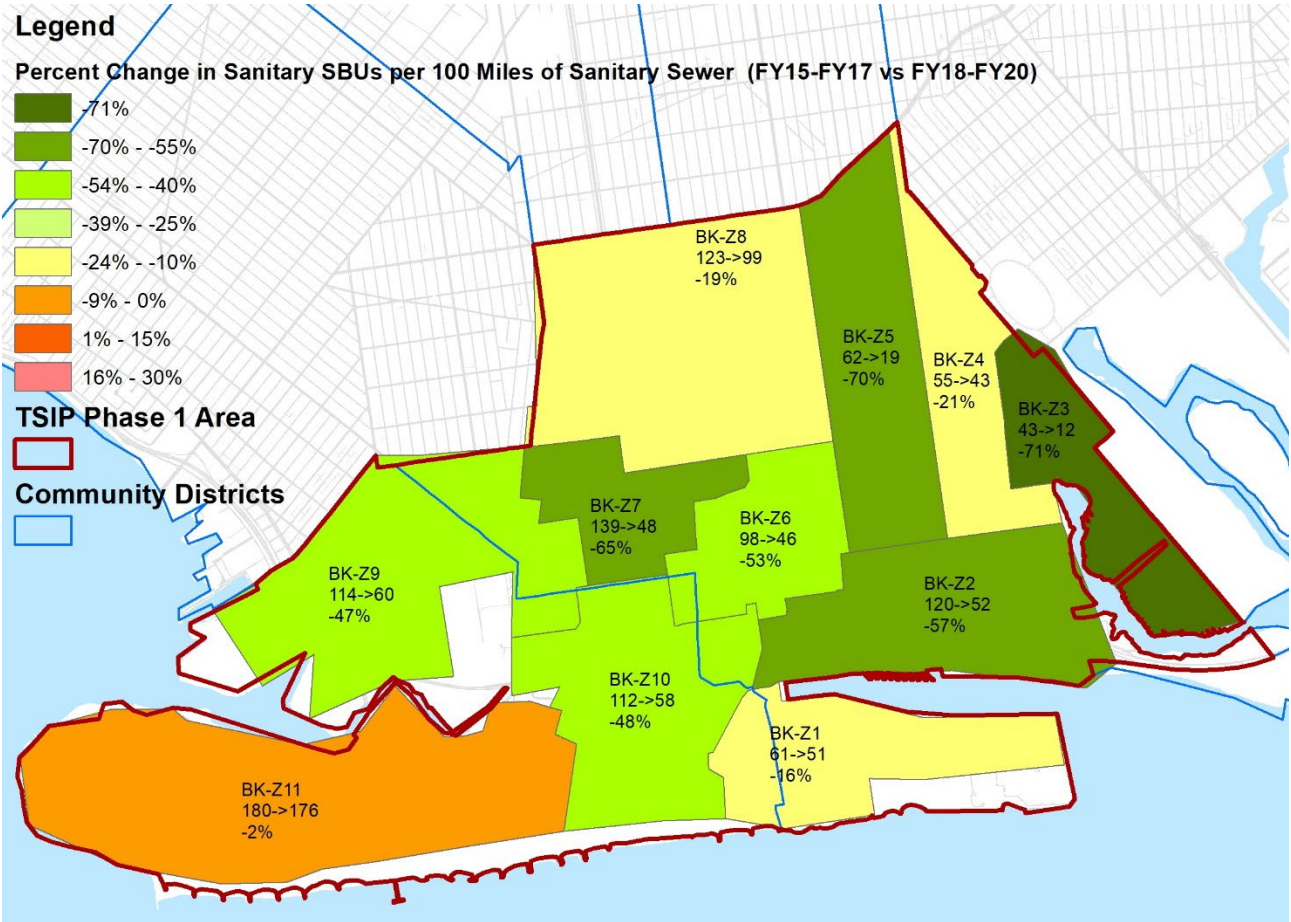
The charts below show the SBU counts and SBU rates in each Brooklyn sub-sewershed over time by fiscal year:

Zone	BK-Z1		BK-Z2		BK-Z3		BK-Z4		BK-Z5		BK-Z6		BK-Z7	
FY	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi
FY2010	39	222.31	61	367.00	5	30.53	36	311.98	39	218.69	24	195.12	26	251.36
FY2011	39	222.31	18	108.29	18	109.90	17	147.33	37	207.48	32	260.17	27	261.03
FY2012	33	188.11	10	60.16	13	79.37	12	103.99	26	145.80	16	130.08	19	183.69
FY2013	16	91.21	44	264.72	17	103.79	22	190.66	18	100.94	21	170.73	19	183.69
FY2014	4	22.80	16	96.26	13	79.37	17	147.33	11	61.68	9	73.17	24	232.02
FY2015	3	17.10	20	120.33	10	61.05	11	95.33	13	72.90	13	105.69	15	145.02
FY2016	16	91.21	27	162.44	5	30.53	5	43.33	10	56.08	14	113.82	22	212.69
FY2017	13	74.10	13	78.21	6	36.63	3	26.00	10	56.08	9	73.17	6	58.01
FY2018	5	28.50	18	108.29	3	18.32	10	86.66	5	28.04	9	73.17	4	38.67
FY2019	4	22.80	7	42.11	3	18.32	2	17.33	3	16.82	4	32.52	5	48.34
FY2020	18	102.61	1	6.02	0	0.00	3	26.00	2	11.22	4	32.52	6	58.01
Average Sanitary SBUs per 100mi of Sanitary Sewer	190	98.46	235	128.53	93	51.62	138	108.72	174	88.70	155	114.56	173	152.05

Zone	BK-Z8		BK-Z9		BK-Z10		BK-Z11		Average Sanitary SBUs per 100mi of Sanitary Sewer	
FY	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi
FY2010	137	542.09	36	161.84	70	360.98	68	296.20	541	268.92
FY2011	114	451.08	52	233.77	65	335.20	51	222.15	470	232.61
FY2012	80	316.55	49	220.28	60	309.41	50	217.79	368	177.75
FY2013	87	344.25	40	179.82	36	185.65	29	126.32	349	176.52
FY2014	37	146.40	36	161.84	11	56.73	21	91.47	199	106.28
FY2015	24	94.96	21	94.41	32	165.02	48	209.08	210	107.35
FY2016	37	146.40	19	85.41	15	77.35	37	161.17	207	107.31
FY2017	32	126.62	36	161.84	18	92.82	39	169.88	185	86.67
FY2018	34	134.53	14	62.94	16	82.51	36	156.81	154	74.40
FY2019	11	43.53	16	71.93	6	30.94	42	182.95	103	47.96
FY2020	30	118.71	10	44.95	12	61.88	43	187.30	129	59.02
Average Sanitary SBUs per 100mi of Sanitary Sewer	623	224.10	329	134.46	341	159.86	464	183.74	2915	131.35

In Queens, 21 of the 25 zones showed a decrease in the SBU rate. Those that showed an increase were Queens Zones QN-Z2, QN-Z15, QN-Z18, and QN-Z25. In QN-Z2 and QNZ25, the SBU rate was already low, and the 27% and 20% increases correspond to just 3 SBUs in each zone.
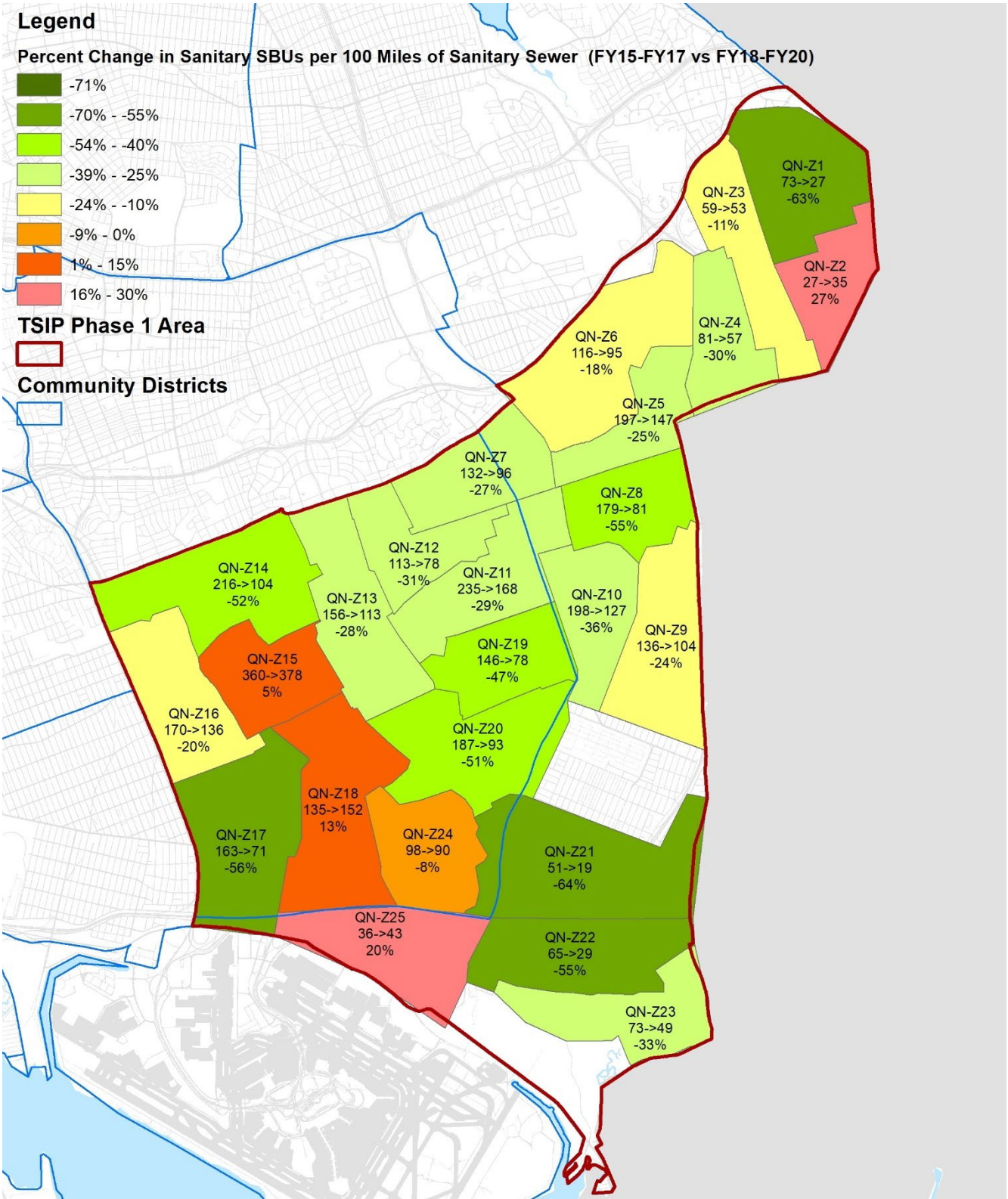
Zone	Sanitary Sewer Miles	Combined Sewer Miles	Sanitary SBUs FY15-FY17	Sanitary SBUs FY18-FY20	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY15-FY17	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY18-FY20	Percent Change in SBU Rate
QN-Z1	17.32	0.03	38	14	73.13	26.94	-63%
QN-Z2	13.43	0.08	11	14	27.31	34.76	27%
QN-Z3	15.83	0.26	28	25	58.95	52.63	-11%
QN-Z4	13.51	0.40	33	23	81.42	56.75	-30%
QN-Z5	13.35		79	59	197.19	147.27	-25%
QN-Z6	22.71		79	65	115.97	95.42	-18%
QN-Z7	18.66		74	54	132.18	96.46	-27%
QN-Z8	15.28		82	37	178.93	80.74	-55%
QN-Z9	13.19	7.38	54	41	136.45	103.60	-24%
QN-Z10	15.18	2.11	90	58	197.58	127.33	-36%
QN-Z11	21.88	0.05	154	110	234.64	167.60	-29%
QN-Z12	15.37	0.13	52	36	112.74	78.05	-31%
QN-Z13	20.92		98	71	156.16	113.14	-28%
QN-Z14	29.74	0.04	193	93	216.30	104.23	-52%
QN-Z15	18.96	0.01	205	215	360.40	377.98	5%
QN-Z16	22.57		115	92	169.87	135.89	-20%
QN-Z17	27.18		133	58	163.12	71.13	-56%
QN-Z18	23.17		94	106	135.21	152.47	13%
QN-Z19	17.11	0.90	75	40	146.15	77.95	-47%
QN-Z20	16.54	5.59	93	46	187.42	92.70	-51%
QN-Z21	21.59	10.87	33	12	50.94	18.52	-64%
QN-Z22	19.39		38	17	65.33	29.23	-55%
QN-Z23	19.53		43	29	73.39	49.50	-33%
QN-Z24	12.98		38	35	97.57	89.87	-8%
QN-Z25	13.89	0.06	15	18	35.99	43.19	20%

Below are the top five Queens sub-sewersheds ordered by the highest rates of sanitary SBUs during the TSIP Phase 1 program:

Zone	Sanitary Sewer Miles	Combined Sewer Miles	Sanitary SBUs FY15-FY17	Sanitary SBUs FY18-FY20	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY15-FY17	Sanitary SBUs per 100Mi of Sanitary Sewer per Year FY18-FY20	Percent Change in SBU Rate
QN-Z15	18.96	0.01	205	215	360.40	377.98	5%
QN-Z11	21.88	0.05	154	110	234.64	167.60	-29%
QN-Z18	23.17		94	106	135.21	152.47	13%
QN-Z5	13.35		79	59	197.19	147.27	-25%
QN-Z16	22.57		115	92	169.87	135.89	-20%

The charts below show the sanitary SBU rates in each Queens sub-sewershed over time:

Queens

Zone	QN-Z1		QN-Z2		QN-Z3		QN-Z4		QN-Z5		QN-Z6		QN-Z7	
FY	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi
FY2010	31	178.97	24	178.76	9	56.84	33	244.26	54	404.35	63	277.45	99	530.52
FY2011	28	161.65	21	156.41	11	69.47	22	162.84	56	419.33	51	224.60	83	444.78
FY2012	10	57.73	15	111.72	4	25.26	18	133.23	59	441.80	42	184.97	56	300.09
FY2013	8	46.18	9	67.03	9	56.84	19	140.63	41	307.01	53	233.41	59	316.17
FY2014	12	69.28	7	52.14	7	44.21	18	133.23	38	284.55	30	132.12	28	150.05
FY2015	13	75.05	5	37.24	7	44.21	13	96.22	29	217.15	30	132.12	27	144.69
FY2016	13	75.05	6	44.69	7	44.21	13	96.22	23	172.23	25	110.10	20	107.18
FY2017	12	69.28	0	0.00	14	88.42	7	51.81	27	202.18	24	105.70	27	144.69
FY2018	6	34.64	13	96.83	11	69.47	15	111.03	17	127.30	17	74.87	22	117.89
FY2019	4	23.09	0	0.00	9	56.84	3	22.21	34	254.59	21	92.48	12	64.31
FY2020	4	23.09	1	7.45	5	31.58	5	37.01	8	59.90	27	118.91	20	107.18
Average Sanitary SBUs per 100mi of Sanitary Sewer	**141**	**74.00**	**101**	**68.39**	**93**	**53.40**	**166**	**111.70**	**386**	**262.76**	**383**	**153.34**	**453**	**220.69**

Queens

Zone	QN-Z8		QN-Z9		QN-Z10		QN-Z11		QN-Z12		QN-Z13		QN-Z14	
FY	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi
FY2010	49	320.77	36	272.89	73	480.77	92	420.52	38	247.17	103	492.38	209	702.70
FY2011	37	242.22	30	227.41	83	546.63	98	447.95	43	279.69	66	315.51	172	578.30
FY2012	18	117.83	28	212.25	39	256.85	65	297.11	33	214.64	59	282.04	115	386.65
FY2013	20	130.93	16	121.29	68	447.84	82	374.81	21	136.59	72	344.19	112	376.57
FY2014	33	216.03	25	189.51	41	270.02	51	233.12	21	136.59	32	152.97	74	248.80
FY2015	34	222.58	21	159.19	30	197.58	48	219.40	23	149.60	40	191.22	59	198.37
FY2016	37	242.22	11	83.38	22	144.89	61	278.82	20	130.09	32	152.97	80	268.98
FY2017	11	72.01	22	166.77	38	250.26	45	205.69	9	58.54	26	124.29	54	181.56
FY2018	19	124.38	22	166.77	22	144.89	40	182.84	15	97.57	22	105.17	36	121.04
FY2019	6	39.28	6	45.48	23	151.47	31	141.70	14	91.06	22	105.17	34	114.32
FY2020	12	78.56	13	98.55	13	85.62	39	178.26	7	45.53	27	129.07	23	77.33
Average Sanitary SBUs per 100mi of Sanitary Sewer	**276**	**164.25**	**230**	**158.50**	**452**	**270.62**	**652**	**270.93**	**244**	**144.28**	**501**	**217.73**	**968**	**295.87**

Queens

Zone	QN-Z15		QN-Z16		QN-Z17		QN-Z18		QN-Z19		QN-Z20		QN-Z21	
FY	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi
FY2010	171	901.88	70	310.19	108	397.37	105	453.10	68	397.52	53	320.42	29	134.30
FY2011	159	838.59	80	354.50	148	544.54	94	405.64	65	379.99	58	350.65	31	143.56
FY2012	146	770.02	60	265.88	88	323.78	46	198.50	33	192.92	61	368.79	11	50.94
FY2013	101	532.69	52	230.43	59	217.08	58	250.29	62	362.45	50	302.28	21	97.25
FY2014	107	564.33	47	208.27	40	147.17	49	211.45	23	134.46	35	211.60	9	41.68
FY2015	98	516.86	48	212.70	39	143.49	34	146.72	26	151.99	29	175.32	8	37.05
FY2016	66	348.09	41	181.68	55	202.36	26	112.20	33	192.92	29	175.32	9	41.68
FY2017	41	216.24	26	115.21	39	143.49	34	146.72	16	93.54	35	211.60	16	74.10
FY2018	81	427.20	45	199.41	32	117.74	33	142.40	18	105.23	19	114.87	5	23.16
FY2019	74	390.29	14	62.04	12	44.15	33	142.40	9	52.61	14	84.64	2	9.26
FY2020	60	316.45	33	146.23	14	51.51	40	172.61	13	76.00	13	78.59	5	23.16
Average Sanitary SBUs per 100mi of Sanitary Sewer	**1104**	**529.33**	**516**	**207.87**	**634**	**212.06**	**552**	**216.55**	**366**	**194.51**	**396**	**217.64**	**146**	**61.47**

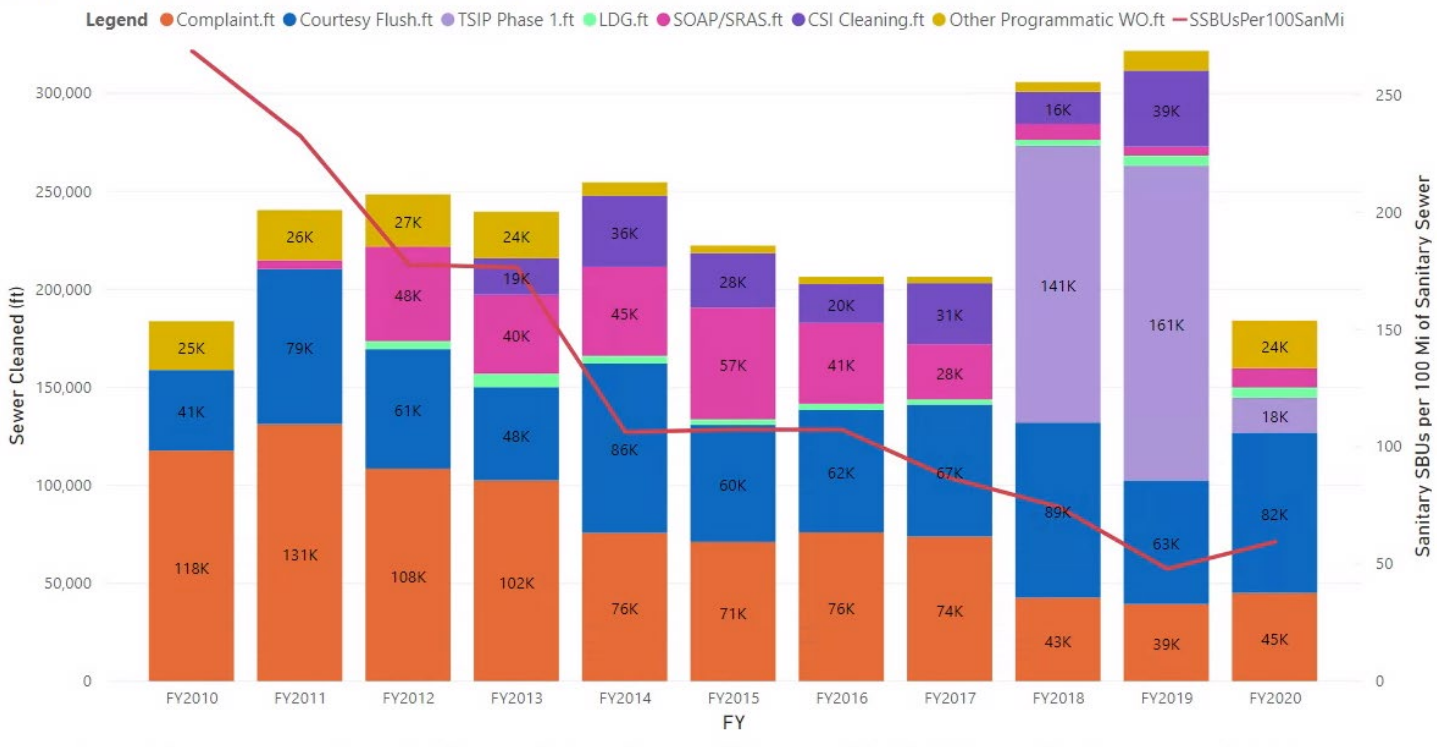| Zone | QN-Z22 | | QN-Z23 | | QN-Z24 | | QN-Z25 | | **Average** | |
FY	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	SSBUs	SSBUs Per 100 SanMi	**SSBUs**	**SSBUs Per 100 SanMi**
FY2010	29	149.58	28	143.37	43	331.22	4	28.79	**1621**	335.04
FY2011	24	123.79	30	153.61	42	323.52	13	93.58	**1545**	319.55
FY2012	20	103.16	19	97.28	24	184.87	10	71.98	**1079**	226.01
FY2013	20	103.16	89	455.70	26	200.27	8	57.59	**1135**	236.35
FY2014	18	92.84	22	112.64	10	77.03	13	93.58	**790**	168.31
FY2015	12	61.89	15	76.80	14	107.84	7	50.39	**709**	150.63
FY2016	9	46.42	13	66.56	11	84.73	6	43.19	**668**	137.85
FY2017	17	87.68	15	76.80	13	100.14	2	14.40	**570**	120.04
FY2018	8	41.26	15	76.80	19	146.35	6	43.19	**558**	120.49
FY2019	7	36.10	7	35.84	6	46.22	4	28.79	**401**	85.37
FY2020	2	10.32	7	35.84	10	77.03	8	57.59	**409**	84.93
Average Sanitary SBUs per 100mi of Sanitary Sewer	**166**	**77.84**	**260**	**121.02**	**218**	**152.66**	**81**	**53.00**	**9485**	**180.42**

5.3 Sewer Work

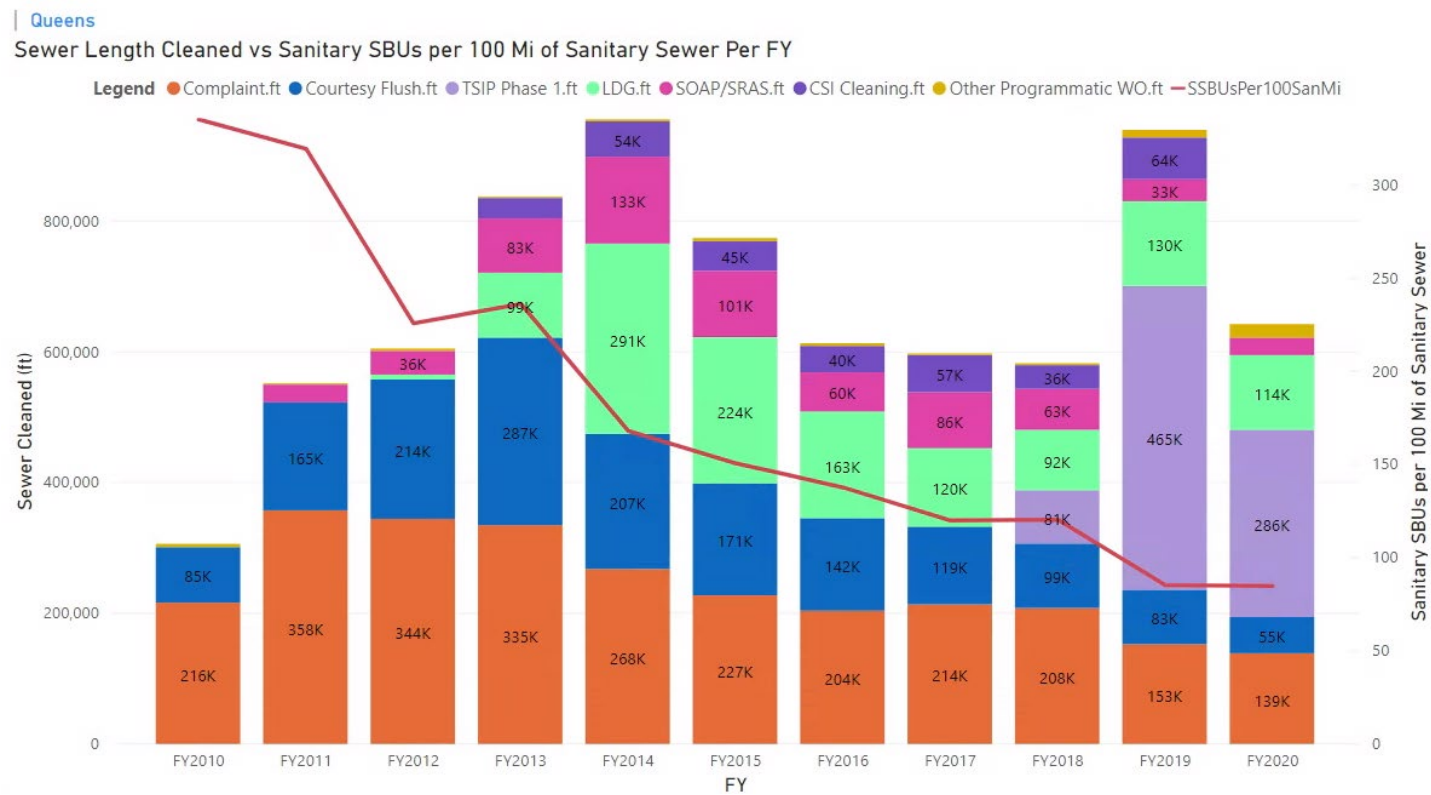### 5.3.1 TSIP Phase 1 Inspection-Generated Sewer Work

Phase 1 of the TSIP inspections generated 7,143 flow-related work orders; addressing these work orders included cleaning of a total of 1.15 million feet (218 miles) of sewer. These work orders, as well as all other sewer cleaning work in the TSIP Phase 1 Community Boards from FY2010 to FY2020, were plotted against the rate of confirmed SBUs on sanitary sewer segments.

In Brooklyn, DEP completed most TSIP Phase 1 work in FY18 and FY19, with ~ 5% completed in FY20.

| Brooklyn

Sewer Length Cleaned vs Sanitary SBUs per 100 Mi of Sanitary Sewer Per FY

In Queens, most work was completed in FY19 and FY20.

Queens
Sewer Length Cleaned vs Sanitary SBUs per 100 Mi of Sanitary Sewer Per FY

Legend ●Complaint.ft ●Courtesy Flush.ft ●TSIP Phase 1.ft ●LDG.ft ●SOAP/SRAS.ft ●CSI Cleaning.ft ●Other Programmatic WO.ft ─SSBUsPer100SanMi

5.4 "Variable" Relationships

DEP performed this analysis to assess whether SBU rates or sewer conditions found during TSIP Phase 1 inspections related to various infrastructure and environment variables. The variables that showed the strongest correlations between inspection results and SBUs were determined to be sewer size, sewer age, and sewer flow beginning on a segment (dead end and crown sewers). However, because these "variable" relationships are averages over large geographic areas, DEP has determined that they would not be effective or instructive for assignment of inspection or maintenance frequencies on a street-by street basis or for determining further action in the TSIP Phase 1 areas.
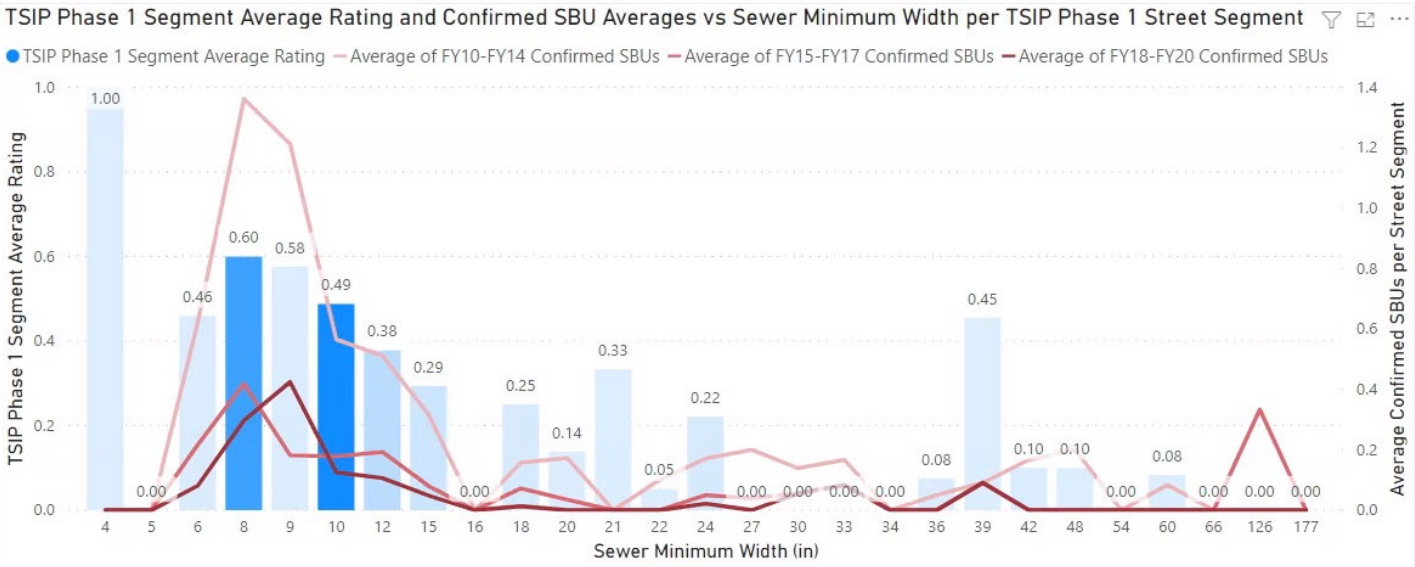
5.4.1 Sewer Characteristics

DEP aggregated each sewer segment in the TSIP Phase 1 areas by the nearest street segment to create a dataset of sewer characteristics per city block.
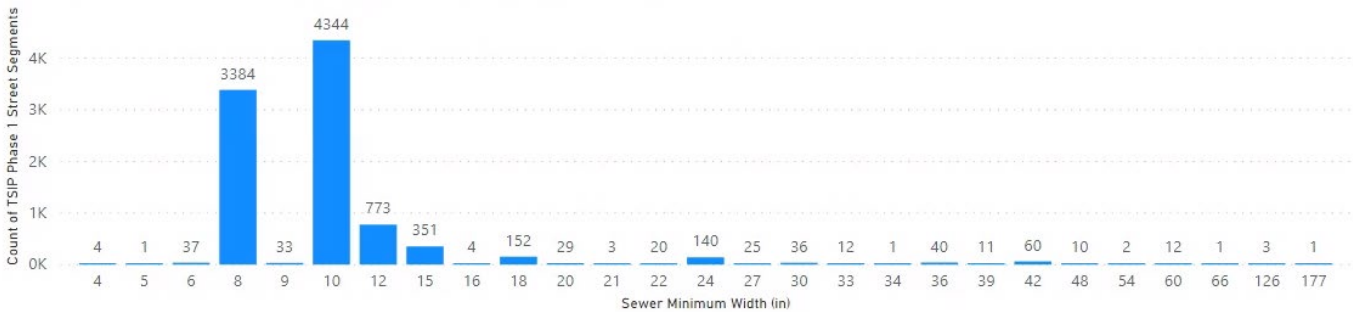
The variables investigated and the summary findings are below:

1. **Minimum Sewer Width**
   a. Generally, 8" sewers have higher SBU rates and a higher rate of issues found during TSIP Phase 1 inspections than do 10" and 12" sewers in the TSIP Phase 1 Community Boards. These smaller sewers tend to be older, with 8" sewers across the TSIP Phase 1 Community Boards having an average age of 84 years, 10" and 12" having an average age of 65 years.
   b. The first chart below shows the average TSIP Phase 1 segment rating for each minimum sewer width overlaid by the average number of confirmed SBUs occurring per street segment for that sewer width for three periods – from FY2010 to FY2014, from FY2015 to FY2017, and from FY2018 to FY2020. The bar transparency indicates the number of street segments, which is also shown in the bottom chart.
   c. One segment was missing sewer width data.

TSIP Phase 1 Segment Average Rating and Confirmed SBU Averages vs Sewer Minimum Width per TSIP Phase 1 Street Segment

● TSIP Phase 1 Segment Average Rating — Average of FY10-FY14 Confirmed SBUs — Average of FY15-FY17 Confirmed SBUs — Average of FY18-FY20 Confirmed SBUs

Count of TSIP Phase 1 Street Segments by Sewer Minimum Width (in)


AVERAGE CONFIRMED SBUS PER TSIP PHASE 1 STREET SEGMENT

Sewer Minimum Width (in)	TSIP Phase 1 Street Segment Count	Average of FY10-FY14 Confirmed SBUs	Average of FY15-FY17 Confirmed SBUs	Average of FY18-FY20 Confirmed SBUs
4	4	0.00	0.00	0.00
5	1	0.00	0.00	0.00
6	37	0.62	0.22	0.08
8	3384	1.36	0.42	0.30
9	33	1.21	0.18	0.42
10	4344	0.57	0.18	0.13
12	773	0.51	0.19	0.11
15	351	0.32	0.08	0.05
16	4	0.00	0.00	0.00
18	152	0.16	0.07	0.01
20	29	0.17	0.03	0.00
21	3	0.00	0.00	0.00
22	20	0.10	0.00	0.00
24	140	0.17	0.05	0.02
27	25	0.20	0.04	0.00
30	36	0.14	0.06	0.06
33	12	0.17	0.08	0.08
34	1	0.00	0.00	0.00
36	40	0.05	0.00	0.00
39	11	0.09	0.09	0.09
42	60	0.17	0.00	0.00
48	10	0.20	0.00	0.00
54	2	0.00	0.00	0.00
60	12	0.08	0.00	0.00
66	1	0.00	0.00	0.00
126	3	0.00	0.33	0.00
177	1	0.00	0.00	0.00
Total	**9489**	**0.81**	**0.25**	**0.18**

2. **Sewer Material**
    a. DEP evaluated this variable per manhole, not per street segment, as there were too many material combinations to assess when evaluating by street segment.
    b. 7,750 manholes (29%) did not have a sewer material associated with any intersecting sewers. For each manhole with known sewer materials, the most common non-clay sewer material was determined. If a manhole intersected only clay sewers, the inspection would be assigned "clay." If a manhole intersected a clay sewer and a sewer made of another material, the manhole would be assigned the non-clay material.
    c. Clay sewers had the worst average inspection result followed by metal sewers and then concrete sewers.

Average TSIP Phase 1 Manhole Inspection Result and Manhole Count by Least Common Sewer Material Per Manhole
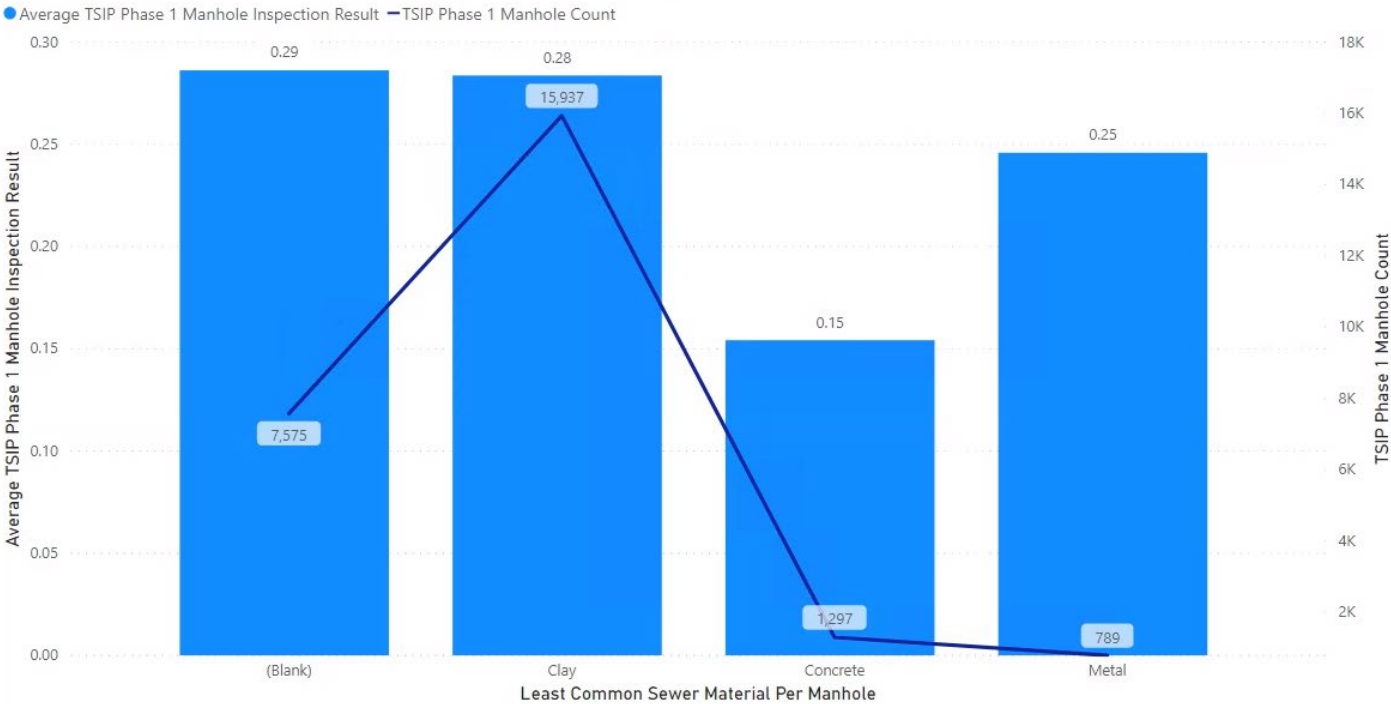
3. **Sewer Slope**

Only 1,672 (17%) of TSIP Phase 1 street segments had sewer slope data available. DEP decided the results of this analysis were not representative of the sewer system due to the large amount of missing data (83%)

4. **Oldest Sewer Age**

DEP found higher TSIP Phase 1 segment ratings and a small increase in confirmed SBU rates with increasing sewer age per street segment. This metric corresponds roughly to sewer size, as smaller sewers tend to be older as well. Below are two charts illustrating this relationship.

TSIP Phase 1 Segment Average Rating and Confirmed SBU Averages vs Maximum Sewer Age per TSIP Phase 1 Street Segment


Count of TSIP Phase 1 Street Segments by Sewer Oldest Age (Nearest 10 Years)
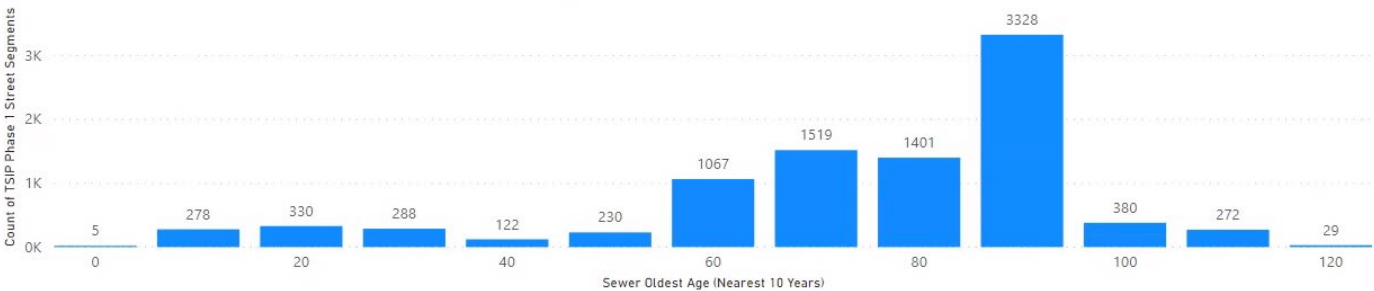
5. **Dead End and Crown Sewers**

Dead End Sewer and Crown Sewer street segments are those where sewer flow starts, i.e., street segments containing a manhole with an outlet pipe(s) but no inlet pipe. DEP has observed during Phase 1 that these segments tend to have lower flow than pass-through segments (segments where all manholes have an inlet pipe and an outlet pipe) and had higher rates of SBUs and lower TSIP Phase 1 inspection ratings. Crown segments tend to have lower TSIP Phase 1 segment ratings and more SBUs than dead end segments.
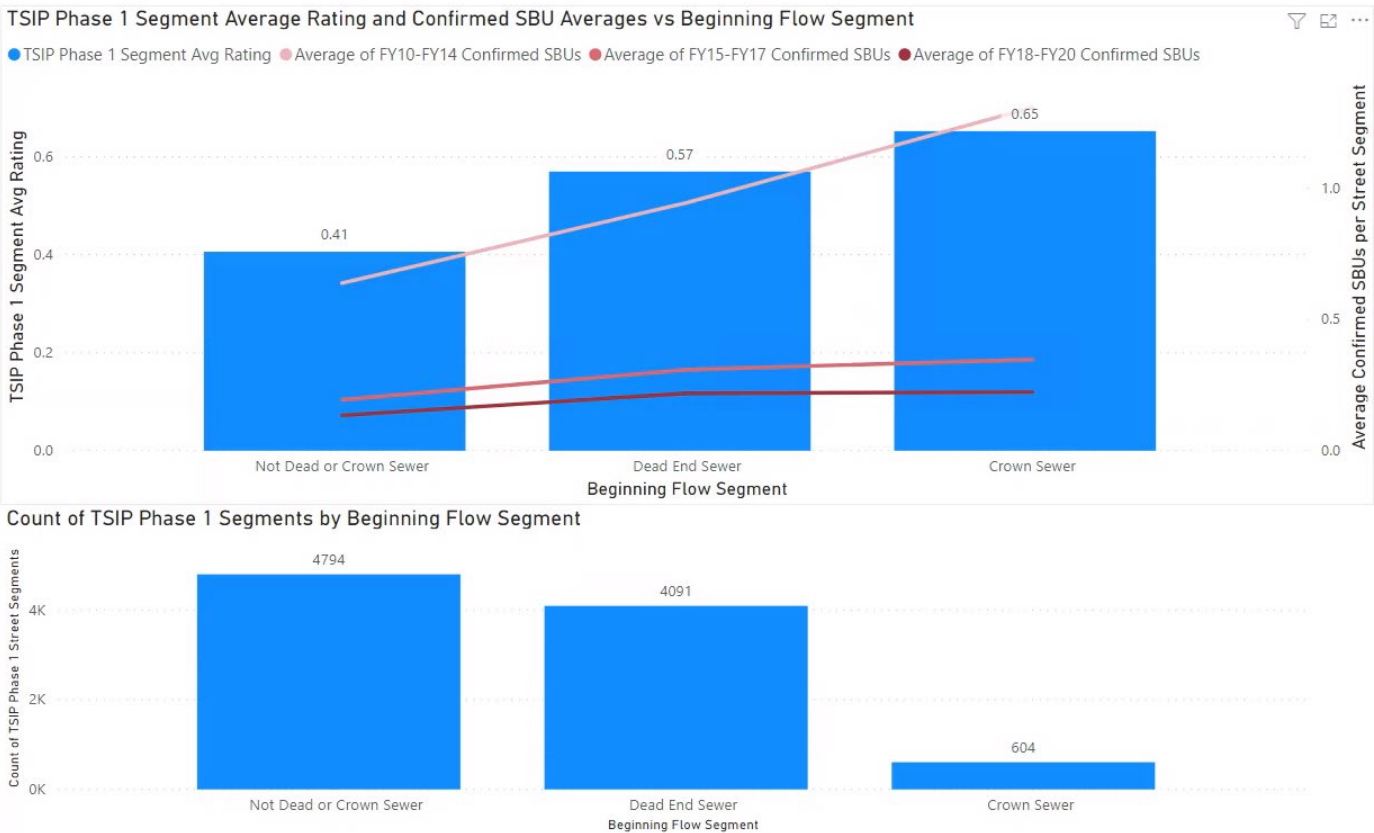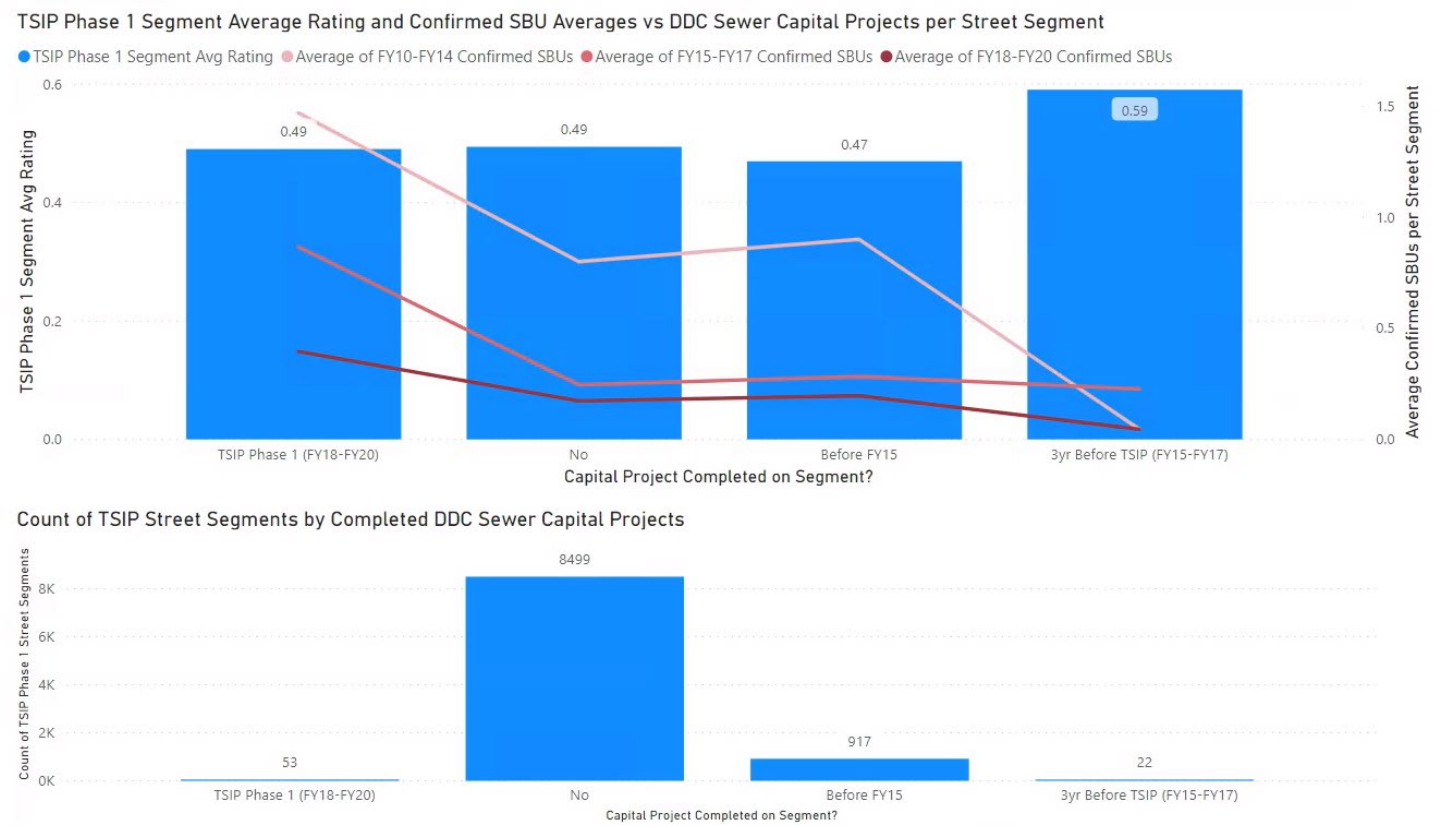

5.4.2 Tax Lot Characteristics – TSIP Phase 1

MapPluto was used to assess possible relationships between tax lot data and TSIP Phase 1 inspection results and SBUs. MapPluto tax lot polygons were joined to the nearest street segment and the following variables were assessed:

1. Tax Lot Units per street Segment
   a. Number of Residential Units & Number of all Units per street segment
      i. In Brooklyn, there is no relationship between TSIP Phase 1 segment ratings/confirmed SBUs and the number of Tax Lot Units per TSIP Phase 1 street segment (Total and Residential)
      ii. In Queens, there initially appeared to be a clear positive relationship between TSIP Phase 1 segment ratings/confirmed SBUS and the number of Tax Lot Units (Total and Residential).
         • However, the length of the street segment and the number of TSIP Phase 1 manholes per segment also increases with the number of units, so increased SBUs in this relationship may be attributed to the increase in the length of sewer serving these TSIP segments.
         • When inspection results are normalized by the number of TSIP Phase 1 manholes on each street segment, the apparent relationship between TSIP Phase 1 inspection results and the number of tax lot units is nullified.
2. Commercial/Retail Floor Space Per Street Segment
   a. Total Commercial Floor Space per street segment and Total Retail Floor Space per street segment
   b. There was no relationship found in either Brooklyn or Queens between commercial/retail floor space and TSIP Phase 1 segment ratings or SBUs.
3. Average Number of Building Floors per street segment
   a. No relationship was found between average building floors per street segment and confirmed SBUs except in Community Board 413, where there was a slight increase in confirmed SBUs with increasing average number of building floors.
4. Building Age
   a. There is no clear relationship between TSIP Phase 1 segment ratings and maximum building age, but there is a slight positive relationship with confirmed SBU rates, which are higher on segments with older buildings.
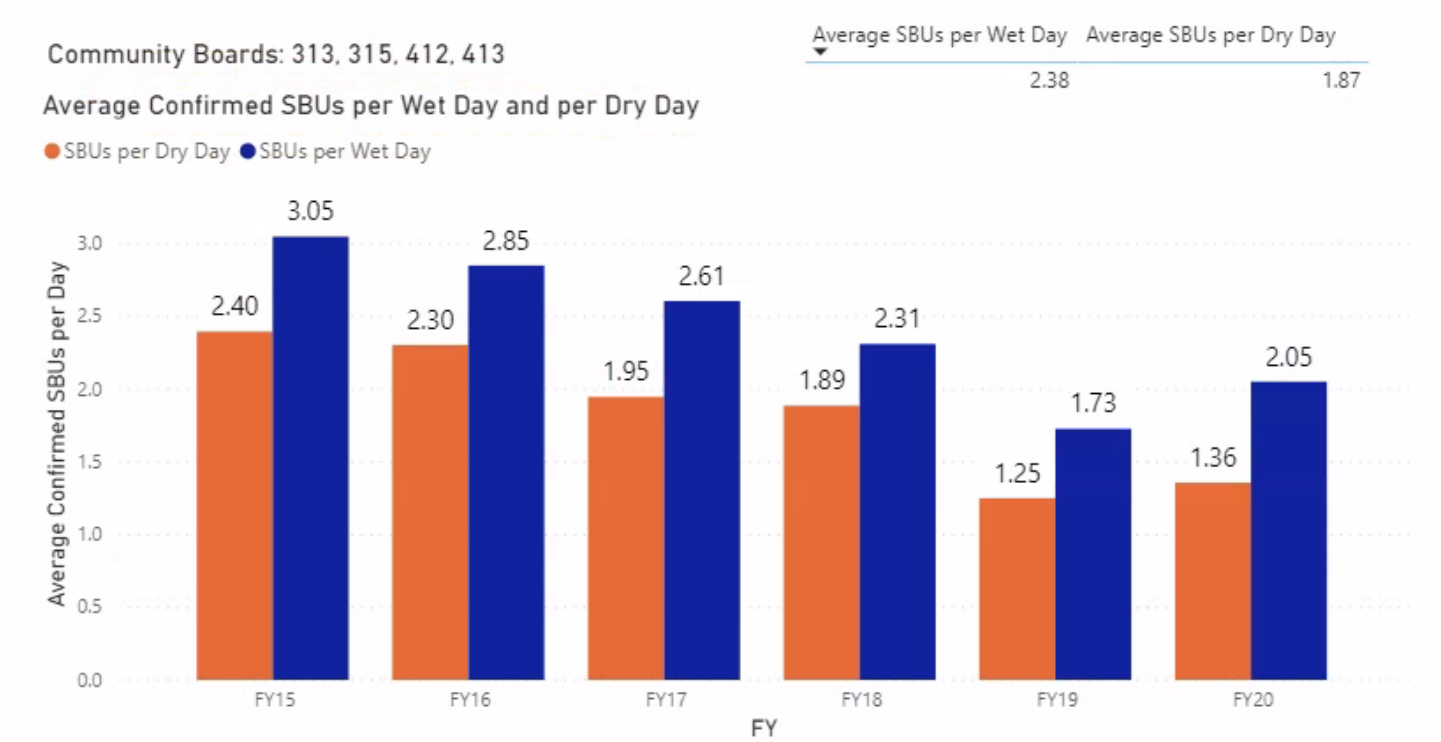
5.4.3 Capital Projects – TSIP Phase 1

899 TSIP Phase 1 segments (7%) had a NYCDDC (Department of Design and Construction) or NYCEDC (Economic Development Corporation) sewer capital project completed since 1993. For those street segments with capital projects completed most recently (but before FY15), both the average TSIP segment rating and average confirmed SBUs was very similar to those segments that did not have DDC capital projects completed in this period. The number of segments with completed projects 3 years before TSIP Phase 1 and the number during TSIP Phase 1 were too small to draw conclusions from.

TSIP Phase 1 Segment Average Rating and Confirmed SBU Averages vs DDC Sewer Capital Projects per Street Segment

● TSIP Phase 1 Segment Avg Rating ● Average of FY10-FY14 Confirmed SBUs ● Average of FY15-FY17 Confirmed SBUs ● Average of FY18-FY20 Confirmed SBUs

Capital Project Completed on Segment?	TSIP Phase 1 Segment Avg Rating
TSIP Phase 1 (FY18-FY20)	0.49
No	0.49
Before FY15	0.47
3yr Before TSIP (FY15-FY17)	0.59

Count of TSIP Street Segments by Completed DDC Sewer Capital Projects

Capital Project Completed on Segment?	Count of TSIP Phase 1 Street Segments
TSIP Phase 1 (FY18-FY20)	53
No	8499
Before FY15	917
3yr Before TSIP (FY15-FY17)	22

5.4.4 Precipitation

Confirmed SBUs in the TSIP Phase 1 Community Boards tend to occur more on wet days than on dry days. The average from FY15 to FY20 is 2.4 SBUs per wet day, compared to 1.9 SBUs per dry day in these Community Boards.

Community Boards: 313, 315, 412, 413

Average Confirmed SBUs per Wet Day and per Dry Day

Average SBUs per Wet Day	Average SBUs per Dry Day
2.38	1.87

● SBUs per Dry Day ● SBUs per Wet Day

FY	SBUs per Dry Day	SBUs per Wet Day
FY15	2.40	3.05
FY16	2.30	2.85
FY17	1.95	2.61
FY18	1.89	2.31
FY19	1.25	1.73
FY20	1.36	2.05

6 Program Expansion

6.1 SOAP Program Recurring SBUs

DEP reviews Confirmed SBU IPS data monthly to determine which sewer segments experienced the greatest number of Confirmed SBUs during the previous 3-month period. SOAP Segments are currently defined as those street segments that have more than one Confirmed SBU within a rolling three-month period. DEP then issues internal Customer Service Requests on these locations to initiate an inspection that includes a root cause analysis to determine the cause of the Confirmed SBUs and any appropriate remedial actions.

6.1.1 3-Month Rolling Average vs 12-Month Rolling Average

DEP performed an analysis to assess the increased volume of work that would be generated if the 3-month rolling period for identifying recurring SBUs were increased to 12 months. For this analysis, DEP used all confirmed SBUs citywide excluding the Ozone Park Incident and Lakeview Blvd SBUs and created a model to simulate the change from the 3-month rolling period to the 12-month rolling period. DEP assessed, for each month from July FY18 through June FY19, recurring SBUs on individual street segments in a 3-month rolling period. Starting in July FY20 through July FY21, the model switched the period assessed for recurring SBUs from 3 months to 12 months. For each month assessed, segments already identified as recurring during the previous 12 months were removed as duplicates.

For the first month (July FY20) of comparing a 12-month rolling average to 3-month rolling average, DEP found an increment of 58 segments over the 15 segments identified in the rolling 3-month period for that month – 387% more segments. After this first month, there were on average an additional 8 segments identified per month.

FY	Month	3 Month Rolling Segments	3 to 12 Month Rolling Segments	Increased Segments 3 -> 12MRA	% Change
FY2019	Aug-2018	27	27	0	0%
FY2019	Sep-2018	12	12	0	0%
FY2019	Oct-2018	18	18	0	0%
FY2019	Nov-2018	20	20	0	0%
FY2019	Dec-2018	28	28	0	0%
FY2019	Jan-2019	33	33	0	0%
FY2019	Feb-2019	21	21	0	0%
FY2019	Mar-2019	24	24	0	0%
FY2019	Apr-2019	18	18	0	0%
FY2019	May-2019	21	21	0	0%
FY2019	Jun-2019	24	24	0	0%
FY2020	Jul-2019	15	73	58	387%
FY2020	Aug-2019	22	30	8	36%
FY2020	Sep-2019	11	17	6	55%
FY2020	Oct-2019	14	20	6	43%
FY2020	Nov-2019	13	25	12	92%
FY2020	Dec-2019	42	51	9	21%
FY2020	Jan-2020	28	40	12	43%
FY2020	Feb-2020	12	17	5	42%
FY2020	Mar-2020	13	21	8	62%
FY2020	Apr-2020	14	22	8	57%
FY2020	May-2020	16	21	5	31%
FY2020	Jun-2020	14	23	9	64%
FY2021	Jul-2020	31	39	8	26%
Total		491	645	154	31%
Model Rolling Period Switches from 3 months to 12 months in July 2019					

To assess the impact of such a change in the longer term, DEP re-ran the model from FY16 to FY20 with the switch from 3 months to 12 months starting in FY17.

- In the first year (FY17) there was a 64% increase in segments (335 to 548 segments).
- In the second year (FY18) there was an increase of 31% (304 to 398 segments).
- In the third year (FY19), there was an increase of 33% (212 to 282 segments).
- In the fourth year (FY20), there was a 24% increase (167 to 207 segments).

This model run shows that the difference between the two rolling periods may decrease over multiple years.

Fiscal Year	3MRA Recurring Segments	12MRA Recurring Segments	Increased Segments 3 ->12MRA	% Difference 3->12MRA
FY2016	439	439	0	0%
FY2017	335	548	213	64%
FY2018	304	398	94	31%
FY2019	212	282	70	33%
FY2020	167	207	40	24%
Grand Total	1457	1874	417	29%
Average	291	375	83	29%
Model Rolling period switches from 3MRA to 12MRA July 1st 2017				

Given the above analysis and current resources, DEP has determined that it will be able to implement a 12-month rolling period for the SOAP program instead of the current 3-month rolling period. DEP will implement this change in July 2021 (FY2022).

6.2 Pilot Phase 2 (August 1, 2020 through July 31, 2023)

6.2.1 New Community Boards for Phase 2

Beginning August 1, 2020, TSIP inspections commenced in additional areas as part of TSIP Phase 2. DEP added to the TSIP program Community Boards 314 and 318 in Brooklyn, and Community Board 410 in Queens, as those have the highest confirmed SBU rates outside of the Phase 1 Community Boards. These Community Boards will follow a similar two-cycle inspection of every sanitary sewer, which DEP expects to complete in two years.

DEP has also included Community Board 501 in Staten Island in the TSIP Phase 2 program as of August 1, 2020. DEP expects to complete a two-cycle inspection of every sanitary sewer in this area in three years.

6.2.2 TSIP Phase 1 Community Boards Inspection Cycle and Area Determination

DEP analyzed the inspection results, confirmed SBUs, proactive maintenance, and reactive maintenance throughout the TSIP Phase 1 areas to detect any patterns of Confirmed SBUs and noted inspection issues related to various factors.[5] DEP used this analysis to identify areas in the original pilot where DEP will perform more targeted or frequent inspections. These inspections will occur alongside those in the new TSIP Phase 2 areas. DEP will continue to evaluate the results of the inspections and make necessary changes to the inspection schedule to prevent Confirmed SBUs and to utilize resources efficiently.

To use the most targeted data available for this schedule, DEP used a decision matrix to assign an inspection cycle to each street segment based on the number of confirmed SBUs in the past five years and the TSIP Phase 1 inspection results for both cycles.

Inspection cycles for this initial matrix occur in 3-month, 6-month, 1-year, 2-year, and 5-year cycles, but inspection cycle intervals may be tweaked further to accommodate available resources.

Inspection Cycle Decision Matrix:

<1 Year since last cleaning (complaint and programmatic)

Confirmed SBU Complaints in last 5 years		TSIP Phase 1 Segment Rating		
		0	1	2
	0	None	5 year	1 year
	1	2 year	1 year	6 month
	2	1 year	6 month	3 month
	3	6 month	6 month	3 month
	4	6 year	3 month	3 month
	>=5	6 month	3 month	3 month

>1 Year since last cleaning (complaint and programmatic)

# Confirmed SBU Complaints in last 5 years		TSIP Phase 1 Segment Rating		
		0	1	2
	0	None	2 year	1 year
	1	1 year	6 month	6 month
	2	1 year	6 month	3 month
	3	6 month	6 month	3 month
	4	6 month	3 month	3 month
	>=5	6 month	3 month	3 month

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[5] As noted above, because the "variable" relationships DEP assessed are averages over large geographic areas, DEP determined that they were would not be effective or instructive for assignment of inspection or maintenance frequencies on a street-by street basis or for determining further action in the TSIP Phase 1 areas.

Reassessment Procedure, run every 3 months:

Two inspections in a row without noting required maintenance: Decrease frequency of inspection to the next lowest interval. Two inspections in a row that note required maintenance: increase frequency of inspection to the next highest interval.

This matrix is projected to generate an average of 12,579 inspections per year in Community Boards 313, 315, 412, and 413 for the next 5 years, with 9,739 inspections per year in Queens and 2,840 per year in Brooklyn.

Queens will implement this matrix immediately. However, because available inspection crews in Brooklyn are nearly fully dedicated to inspecting manholes in TSIP Phase 2 Community Boards 314 and 318, Brooklyn will only implement the matrix fully after the TSIP Phase 2 inspections are complete. Accordingly, initially Brooklyn will only be able to target for inspection the most concerning areas in TSIP Phase 1 Community Boards 313 and 315, with a total of approximately 500 inspections per year through July 2022. Below is a breakdown of the result of applying the matrix to the TSIP Phase 1 data for Brooklyn and Queens.

| Queens
Inspection Cycle Matrix Results

Month Interval	Count of Segments	TSIP Manhole Count
60	1,196	3,254
24	623	1,951
12	818	2,929
6	378	1,368
3	139	612
Not Scheduled	3,841	8,225
Total	**6,995**	**18,339**

Average Inspections/Year

9,739.30

| Brooklyn
Inspection Cycle Matrix Results

Month Interval	Count of Segments	TSIP Manhole Count
60	692	2,358
24	115	504
12	169	699
6	103	499
3	25	105
Not Scheduled	1,391	3,339
Total	**2,495**	**7,504**

Average Inspections/Year

2,840.60

DEP will need to investigate further the technical feasibility of automating such an approach and integrating it into our GIS and IPS workflows. If DEP finds that implementing a dynamic inspection schedule will take a significant amount of time, the results of the matrix will be used to generate a static inspection cycle for the remainder of TSIP Phase 2 until a dynamic inspection generation program can be implemented.

6.2.3 TSIP Phase 1 Community Boards Flushing Program

DEP will also initiate a flushing program in sub-sewersheds that did not see an improvement in SBU rate under the TSIP Phase 1 program. These sub-sewersheds include sewers in Coney Island in Brooklyn (BK-Z11) and South Jamaica in Queens (QN-Z15). DEP will identify and rank the precise sub-sewersheds in order of flushing need based on TSIP Phase 1 results and SBU rates and flush these sewers on a to-be-determined basis.